

Whip spiders of the genus *Sarax* in the Papuan region, with description of two new species (Amblypygi: Charinidae)

Cahyo Rahmadi: Natural History Laboratory, Faculty of Science, Ibaraki University, Mito, 310-8512 Japan and Museum Zoologicum Bogoriense, Research Center for Biology, Indonesian Institute of Sciences (LIPI) Jl. Raya Jakarta-Bogor Km. 46, Cibinong, 16911 Indonesia. E-mail: cahyo.rahmadi@lipi.go.id

Jun-ichi Kojima: Natural History Laboratory, Faculty of Science, Ibaraki University, Mito, 310-8512 Japan

Abstract. Three species of the genus *Sarax* are recognized in the Papuan region. Among them, two species, *Sarax newbritainensis*, new species, from New Britain, and *S. monodenticulatus*, new species, from Waigeo Island are described. *Sarax newbritainensis* resembles *S. willeyi* in having the same number of denticles on the pedipalpal tarsus, but they distinctly differ from each other in body size, form of carapace, length of legs and number and arrangement of the trichobothria of tibia of leg IV. *Sarax monodenticulatus* is distinguished from the other two Papuan species by possessing a single denticle on the pedipalpal tarsus. The taxonomic status and the natural history of the species are discussed.

Keywords: Taxonomy, Waigeo Island, Batanta Island, New Britain, Papua New Guinea, Indonesia

Whip spiders, or Amblypygi, are flattened arachnids characterized by their raptorial pedipalps and the first legs modified into extremely elongate antenniform appendages (Weygoldt 2000). They are mostly active during the night and hide under stones and fallen trees during the day. A total of 143 species belonging to 17 genera in five families are currently known (Harvey 2002, 2003; Armas & Gadar 2004; Weygoldt 2002; 2006; Rahmadi & Harvey 2008). Of these, ten species and two subspecies belong to the charinid genus *Sarax* Simon 1892, which is known from the Oriental and Papuan region (India to the Solomons) (Harvey 2003; see also Weygoldt 2005:12).

Kraepelin (1895) recorded *Sarax sarawakensis* (Thorell 1888) from New Guinea and Solomon Islands, and Pocock (1898) recorded the species from New Britain based on specimens procured by Dr. A. Willey, the director of the Colombo Museum at that time. Gravely (1915) described *S. willeyi* based on the two specimens “preserved in the Indian Museum” and “collected by Dr. Willey in New Britain.”

The other charinid genus occurring in the Papuan region is *Charinus* Simon 1892. The genus occurs pantropically with 35 species and in the Papuan region only one species, *Charinus papuanus* Weygoldt 2006, is known, from the type locality near Port Moresby, Papua New Guinea (Weygoldt 2006).

During a study on whip spiders collected during the “Ekspedisi Widy Nusantara (e-WIN Expedition)” to Raja Ampat Island, West Papua (organized by the Indonesian Institute of Sciences in 2007 and 2008), and based on the examination of some additional specimens from Papua New Guinea and New Britain and the holotype of *Charon*

sarawakensis (= *S. sarawakensis*), we recognized three distinct species of *Sarax* in the Papuan region. Two of them are described here as new to science, and the taxonomic status of *S. willeyi* is discussed.

METHODS

Specimens from the e-WIN expedition examined in this study were preserved in 90–95% ethanol and others in 70–80%. General terminology and pedipalpal spination follow Weygoldt (2000), and pedipalpal terminology follows Harvey and West (1998). We made the measurements (in mm) and drawings using, respectively, an ocular micrometer and a drawing tube mounted on a stereoscopic dissecting microscope (Olympus SZX12). To prepare the digital images of the carapace, we compiled multiple focal planes taken with a digital microscope (KEYENCE VH-5500) using the software Helicon Focus 4.70 (Helicon Soft Ltd. 2009: online at <http://www.heliconsoft.com/heliconfocus.html>). In order to examine the structure of genitalia we lifted the genital operculum. The acronyms of the museums/institutions are as follows: MCSG, Museo Civico di Storia “Giacomo Doria,” Genova, Italy; MCZ, Museum of Comparative Zoology, Cambridge, Massachusetts, USA; MZB, Museum Zoologicum Bogoriense, Cibinong, Indonesia; MNHN, Museum National d’Histoire Naturelle, Paris, France.

The holotype female of *Sarax sarawakensis* (Thorell 1888), lodged in MCSG and labeled “*Sarax sarawakensis* Thor. Sarawak, Viag Doria and Beccari” was examined to compare with the three *Sarax* species treated below.

KEY TO THE CHARINID WHIP SPIDERS OF THE PAPUAN REGION

1. Abdominal sternite III without ventral sac covers *Charinus papuanus* Weygoldt
- Abdominal sternite III with ventral sac covers *Sarax*...
2. Body reddish-brown. Tibia of leg IV with 17 trichobothria (Fig. 4d); pedipalpal tarsus with one denticle (Fig. 4b) *Sarax monodenticulatus* new species
- Body pale brown or dark greenish-brown. Tibia of leg IV with 17 or 19 trichobothria; pedipalpal tarsus with two denticles (Figs. 2c, 3b) 3

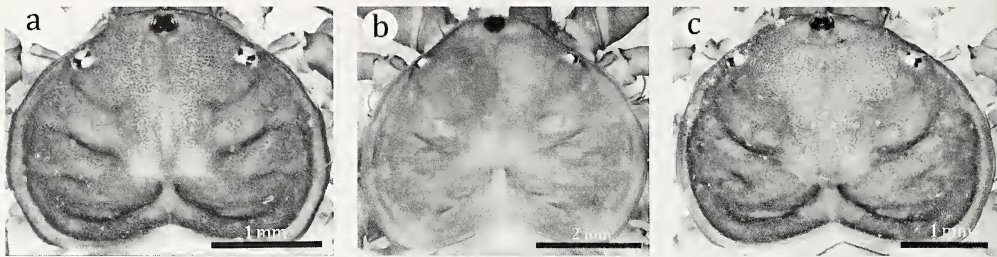


Figure 1.—Carapace. a, *Sarax willeyi* from Batanta Island; b, *Sarax newbritainensis*, holotype from New Britain; c, *Sarax monodenticulatus*, holotype from Waigeo Island.

3. Body pale brown. Legs elongate; tibia of leg IV with 19 trichobothria (Fig. 3e); trichobothrium *bt* close to distal margin; metatarsus of leg I 1.5 times as long as the first tarsal segment *Sarax newbritainensis* new species
 Body dark greenish-brown. Legs not elongate; tibia of leg IV with 17 trichobothria (Fig. 2d); trichobothrium *bt* locating at about mid-length of fourth basitibial segment; metatarsus of leg I as long as the first tarsal segment *Sarax willeyi* Gravely

TAXONOMY

Family Charinidae Quintero 1986

Genus *Sarax* Simon 1892

Sarax Simon 1892:43, 48; Kraepelin 1895:45; Kraepelin 1899:250; Pocock 1900:131; Gravely 1915:441; Mello-Leitão 1931:55; Werner 1935:471; Weygoldt 2000:25; Harvey 2003:7.

Phrynichosarax Gravely 1915:437; Mello-Leitão 1931:52 (as *Phrynichosarax* [sic]); Werner 1935:470; Weygoldt 2000:25 (synonymized with *Sarax*); Weygoldt 2002:146.

Type species.—*Sarax*: *Sarax brachydactylus* Simon 1892, by original designation.

Phrynichosarax: *Phrynichosarax cochinchensis* Gravely 1915, by original designation.

Diagnosis.—Small to medium-sized whip spiders; adult body length 4–10 mm. Pedipalpal patella with three large primary spines, the distal spine largest, subsequent spines becoming shorter proximally; ventral sac covers present on abdominal sternite III. Lateral eyes close to lateral margin of carapace. Basitibia of leg IV consisting of three or four segments.

Remarks.—The family Charinidae currently consists of the following three genera: *Sarax*, *Catageus* Thorell 1889 with a single species from Myanmar, and *Charinus* consisting of 35 species with a circum-tropical distribution (Harvey 2003; Weygoldt & Van Damme 2004; Weygoldt 2006). *Sarax* is, in general, similar to *Charinus*, especially in the pedipalpal patella spination, but clearly distinguished by the presence/absence of the ventral sac cover; in *Sarax* the ventral sac cover is present, while it is absent in *Charinus*. *Catageus* can be distinguished from the other two genera by the second spine of the pedipalpal patella being the largest (in other two genera, the first is the largest) and the proximal spine of the antero-dorsal pedipalpal tibia being larger than the distal one (Weygoldt 2000).

Sarax willeyi Gravely 1915

(Figs. 1a, 2a–g)

Sarax willeyi Gravely 1915:441, fig. 7; Mello-Leitão 1931:55; Werner 1935:471; Kraus 1970, figs. 10–11; Harvey 2003:9.

Material examined.—INDONESIA: *West Papua Province*: 3 females (MZB.Ambl.119–120 and 121 [ovigerous]), under stone in forest near Gua Eleg (00°53.51'S, 130°40.06'E, 156 m asl.), Wailebet, Raja Ampat Regency, Batanta Island, 1 May 2008, C. Rahmadi; 4 males (MZB.Ambl.122, 125–127), 1 female (MZB.Ambl.123, ovigerous with 7 eggs), under stone in small limestone forest near Gua Umso (00°49.89'S, 130°53.82'E), Yenanas, Raja Ampat Regency, 27 April 2008, C. Rahmadi; 1 male (MZB.Ambl.128), Solol Village, Salawati Island, 7 May 2008, C. Rahmadi. PAPUA NEW GUINEA: *Madang Province*: 2 males, 3 females (MZB.Ambl. 129–133), 2 males, 2 females (MCZ DNA104752), Madang Bitabag Reserve, (05°08'19.3"S, 145°46'28.2"E, 109 m asl.), 28 March 2006, R.M. Clouse, Ulai & Nataniel.

Diagnosis.—*Sarax willeyi* differs from other congeneric species from the region by its small size (adult body length about 4.0–6.2 mm) and dark greenish-brown body. The legs are proportionally shorter than other species. The pedipalpal tibia has two spines on the antero-dorsal margin; the proximal spine more than half as long as the distal one. Pedipalpal tarsi with two denticles; proximal denticle about half as long as distal one. Tibia of leg IV with 17 trichobothria; trichobothrium *bc* much closer to *bf* than to *sbf*, and *bt* at about mid-length of the fourth basitibial segment (Fig. 2d). The metatarsal segment of leg I as long as the subsequent two segments together.

Description.—*Male*: Color in alcohol. Carapace dark greenish-brown with yellow marks centrally. Pedipalps and legs green except as follows: major spines of pedipalps light brown; tibia and tarsus of leg I with yellow annulations; distal and proximal margins of basitibiae of Legs II–IV brown; distibiae and tarsi of Legs II–IV light green. Abdomen green with brown spots on each tergite.

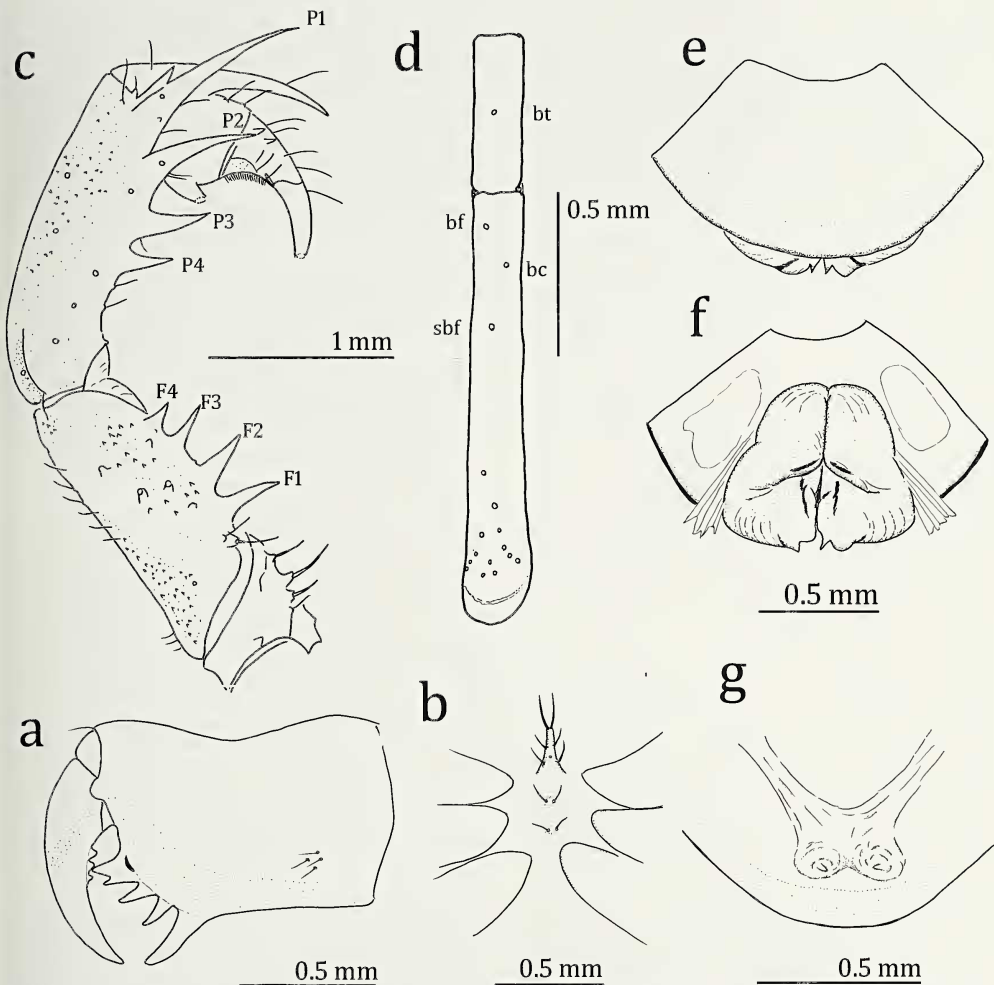


Figure 2.—*Sarax willeyi*, from Batanta Island. a. External view of left chelicera; b. Sternal area of carapace, ventral view; c. Antero-dorsal view of left pedipalp; d. Arrangement of trichobothria on the fourth basitibial segment and distibia of leg IV; e, f. Male genitalia (e. ventral view; f. dorsal view); g. Dorsal view of female gonopods.

Carapace (Fig. 1a): Width about 1.5 times length; surface finely granulate, without setiferous tubercles; median sulcus deep in posterior one-fourth of the carapace; three sulci running laterally on each lateral half of carapace; flange wide and bend upward; anterior margin rounded, with six fine frontal setae. Median eye tubercle black, without apical setae; slightly emarginated antero-medially to form heart shape; median eyes facing antero-laterally. Lateral eye close to lateral margin of carapace.

Chelicera (Fig. 2a): Dorsum smooth, with one fine frontal seta and three fine lateral setae. Basal segment with four teeth: lowermost tooth largest, uppermost tooth bicuspid, with upper cusp larger than lower cusp; inner surface with seven setae arranged in vertical row; outer surface with small blunt tooth opposite bicuspid tooth and four setae near proximal margin. Movable hand with three teeth about equal in size.

Sternum (Fig. 2b): First sternite (= tritosternum) elongate, with paired apical, median and strong basal setae; second

and third sternites rounded and flattened, with paired apical setae.

Pedipalp (Fig. 2c): Short and stout. Trochanter with four setiferous tubercles arranged in a row along antero-dorsal margin, one spine medially and four setiferous tubercles on antero-ventral margin; ventro-anterior apophysis equipped with ten setiferous tubercles present on distal margin of trochanter. Femur with four major spines, some setiferous tubercles and small tubercles in the antero-dorsal part, length of spine $F1 > F2 > F3 > F4$; area without setiferous tubercles or small tubercles forming narrow band running lengthwise from proximal to distal margin; four major spines, several minor spines and small tubercles on antero-ventral margin; one spine present dorsally of $F1$ and as long as $3/4$ length of $F1$, length of spine $F1 > F11 > F13$, three minor spines between $F1$ and $F11$. Patella with four major spines, several minor spines, several setiferous tubercles and small tubercles on antero-dorsal margin; length of spine $P1 > P2 > P3 > P4$, two minor spines (one in several specimens) between $P1$ and distal margin of patella; three major spines, several setiferous tubercles and small tubercles on antero-ventral margin, length of spines $P1 > P11 > P13$. Tibia with two major spines on antero-dorsal margin, length of proximal spine more than half that of distal one; one major spine on antero-ventral margin close to distal margin of tibia; outer surface of the tibia with several setiferous tubercles, finely granulate. Tarsus completely divided (claw clearly demarcated by articulation), with two denticles on antero-dorsal margin; proximal denticle about $3/4$ as long as distal denticle; cleaning organ ventrally with about 30 modified hairs; apotele present.

Legs (Fig. 2d): Femora of Legs I–IV with small tubercles bearing setae. Tibia and tarsus of leg I consisting of 23 and 41 segments, respectively; tibiae of Legs II and III two-segmented; basitibia of leg IV four-segmented, fourth segment with one trichobothrium (value in parentheses: ratio of the distance from the trichobothrium to the proximal margin of the segment against the length of the segment), *bt* (0.50); distitibiae of Legs II–IV each with 16 trichobothria (Fig. 2d), *bf* (0.07), *sbf* (0.31), *bc* (0.17), *bt* at about mid-length of the segment, *bc* close to *bf* than to *sbf*. Tarsi of Legs II–IV four-segmented; first segment about as long as length of subsequent three segments combined; second segment with light-yellow transverse line; fourth segment without oblique slit; pulvilli present.

Genitalia (Figs. 2e, f): Covered ventrally by genital operculum; paired apically-pointed small median projections present at posterior margin; two brown marks present near the base of projections (Fig. 2e). In dorsal view, paired anteriorly-rounded brown bands present; paired weakly-sclerotized brown markings present medially (Fig. 2f).

Female: Similar to the male. Gonopods with paired finger-like apically pointed projections (Fig. 2g).

Measurements.—Male ($n = 7$), [female ($n = 9$)]; values for segments of the appendages are their lengths. Body length (excluding chelicera) 4.00–6.20 [4.04–6.95]. Carapace: median length 1.75–2.40 [1.48–2.70]; width 1.50–3.60 [2.08–3.75]; median eyes to anterior margin of carapace 0.04–0.05 [0.04–0.05]; distance between lateral eyes 0.92–1.72 [0.80–1.75]; lateral eye to anterior margin of carapace 0.25–0.40 [0.20–0.40]; lateral eye to lateral margin of carapace 0.08–0.25 [0.04–0.25]. Pedipalps: trochanter 0.40–0.80 [0.32–0.75];

femur 1.00–2.28 [0.70–1.90]; patella 1.00–2.60 [1.00–2.40]; tibia 0.40–1.25 [0.28–1.00]; tarsus 0.40–1.00 [0.60–1.25]. Leg I: femur 2.50–4.60 [4.60]; patella 0.35–0.50 [0.32–0.50]. Leg II: femur 1.75–3.20 [1.48–3.25], patella 0.48–0.70 [0.40–0.75]; basitibia 2.08 [0.80–2.25]; distitibia 1.60 [0.84–1.50]; metatarsus + tarsus 1.60 [0.88–1.50]. Leg III: femur 2.25–3.60 [1.68–3.75]; patella 0.48–0.70 [0.40–0.75]; basitibia 1.15–2.80 [1.20–3.00]; distitibia 1.28–1.80 [1.00–2.00]; metatarsus + tarsus 1.05–1.60 [1.00–2.00]. Leg IV: femur 1.85–3.20 [1.52–3.50]; patella 0.35–0.70 [0.40–0.70]; basitibia 1.60–3.00 [1.20–3.15]; distitibia 1.00–1.60 [0.80–1.65]; metatarsus + tarsus 0.95–1.60 [0.80–1.75].

Remarks.—*Sarax willeyi* was described by Gravely (1915) based on two specimens collected by Dr. A. Willey in New Britain, which were stated to be in the Indian Museum in Calcutta. Pocock (1898) examined the specimens collected by Dr. A. Willey in New Britain, compared them with *Sarax* specimens from Luzon Island and Andaman Islands, and having agreed with Kraepelin (1895), he concluded that only the single species, *S. sarawakensis*, was recognized in *Sarax*. Although Gravely (1915) did not refer to Pocock (1898), the specimens collected by Dr. Willey in New Britain that they examined may have been the same.

Gravely (1915) distinguished *S. willeyi* from *S. sarawakensis* by the proximal spine of the pedipalpal tarsus being more than half as long as the distal one (less than half in *S. sarawakensis*). The specimens from Batanta Island, Salawati Island, and Madang in Papua New Guinea that we examined have the proximal spine of the pedipalpal tibia longer than half the length of the distal spine. The holotype of *Charon sarawakensis* (= *Sarax sarawakensis*), on the other hand, has the pedipalpal tibia with the proximal spine shorter than half the length of distal one. In addition, the holotype of *C. sarawakensis* has the pedipalpal tarsus armed with two very small denticles, while all of our specimens identified as *S. willeyi* have the pedipalpal tarsus with two rather long denticles. All the distribution records of *S. sarawakensis* in the Papuan regions including Solomon Islands and Bismarck Archipelago, such as reported by Kraepelin (1899), need reconfirmation. At this moment, it is reasonably considered that *S. sarawakensis* is restricted, in its distribution, to the Oriental region.

Natural history.—We found this whip spider most often under stones, and when specimens were collected during the day, they were found in a resting position attached to the underside of a stone on forest floor. We also collected some individuals under fallen trees in Salawati Island. According to the collection data, the specimens from Madang, Papua New Guinea were collected under rotten logs.

Distribution.—This species occurs in New Britain (Gravely 1915), and is here newly recorded from the West Papua Province of Indonesia, and in the Madang Province of Papua New Guinea (Fig. 5).

Sarax newbritainensis new species
(Figs. 1b, 3a–h)

Type material.—Holotype male, Papua New Guinea, East New Britain Province, New Britain Island, Resurgence Lali Bairaman (GPS coord. approx. 05°39'32.59"S, 151°12'39.91"E), 17 February 2005, R. Sougeat (Expé Papou 2005)

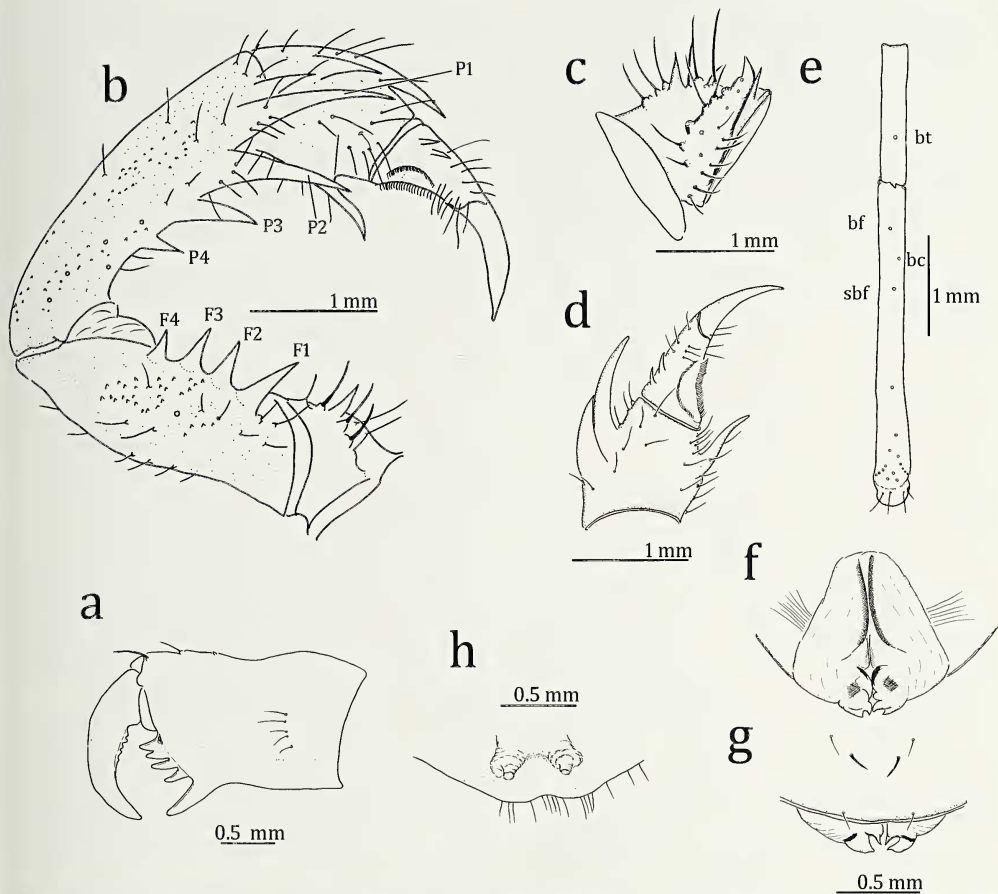


Figure 3.—*Sarax newbritainensis*, new species, from New Britain, Papua New Guinea. a. External view of left chelicerae; b. Antero-dorsal view of left pedipalp; c. Antero-ventral of left pedipalpal trochanter; d. Left pedipalpal tibia; e. Arrangement of trichobothria on fourth basitibial segment and distibia of left leg IV; f, g. Male genitalia (f. dorsal view; g. ventral view); h. Dorsal view of female gonopods.

(MNH.N.Am.6). Paratype: 1 female, same locality data as the holotype (MZB.AmbI.134).

Etymology.—The specific name refers to the island where the type locality is located.

Diagnosis.—*Sarax newbritainensis* differs from all other congeneric species in the region by the large adult body length (about 8.25–9.5 mm) and the pale brown body. The carapace is proportionally less wide, without distinct lateral sulci, and the eyes are reduced in size. The pedipalpal tarsus has two rather long denticles, separated from each other by about twice the basal diameter of the denticle; the proximal denticle is about half as long as the distal one. The legs are elongate; metatarsi of leg II–IV are longer than the length of the subsequent three tarsal segments combined. Tibia of leg IV

with 19 trichobothria, arranged with *bc* situating near the middle of *bf* and *sbf* and *bt* close to the distal margin of the fourth basitibial segment.

Description.—*Male*: Color in alcohol: Carapace light brown with darker marks; pedipalps brown but pedipalpal tarsus light brown. Legs I–IV yellowish brown, without annulations except for tibia and tarsus of leg I having white annulations; patella dark brown.

Carapace (Fig. 1b): Width about 1.3 times the length; surface finely granulate, sparsely with small tubercles, without setiferous tubercles; sulcus deep and distinct on posterior one-fourth of carapace. Flange present from level of lateral eyes to posterior margin, wide and bent upward along lateral margin, narrow on posterior margin. Anterior margin of carapace

rounded, with six frontal setae and four small fine setae close to each antero-lateral corner; slightly concave in part anterior to lateral eyes. Median eye tubercle black, without apical seta, slightly reduced in size, slightly emarginated antero-medially to form heart shape; eyes facing antero-laterally. Lateral eyes close to lateral margin of carapace, distance between them about the diameter of the lateral eye, normal pigmentation and tapetum. Frontal process triangular, visible from above.

Chelicera (Fig. 3a): Dorsum smooth, with three setiferous tubercles and two fine frontal setae. Basal segment with four teeth: the lowermost tooth largest, the uppermost tooth bicuspid, with upper cusp larger than lower cusp; inner surface with 14 setae arranged in vertical row near proximal margin; outer surface with small blunt tooth opposite the bicuspid tooth, and with five setae arranged in vertical row. Movable hand with five teeth; second tooth largest.

Sternum: First sternite (= tritosternum) elongate, with paired apical and strong median setae, five setae between apical and median setae and 12 small setae at base. Second and third sternites rounded, with paired apical setae; second with six basal setae; third with five basal setae.

Pedipalp (Figs. 3b-d): Short and stout, with several setiferous tubercles. Trochanter with a row of seven setiferous tubercles on antero-dorsal margin, six setiferous tubercles dorsally and one median spine on antero-ventral margin, medially with one spine and eight setiferous tubercles; ventral anterior apophysis equipped with several setiferous tubercles in basal part present on distal margin of trochanter (Fig. 3c). Femur with four major spines, several setiferous tubercles and small tubercles on antero-dorsal part, length of spine $F1 > F2 > F3 > F4$; four major spines, several setiferous tubercles and small tubercles on antero-ventral margin, one spine present dorsally of F1 and as long as $3/4$ length of F1, length of spine $F1 > FII > FIII > FIV$, one minor spine between F1 and FII. Patella with four major spines, several setiferous tubercles and small tubercles on antero-dorsal margin, length of spine $P1 > P2 > P3 > P4$; one setiferous tubercle and one spine between P1 and distal margin of patella, the spine as long as half length of P1; three major and one minor spines, several setiferous tubercles and small tubercles on antero-ventral margin, length of spines $P1 > PII > PIII$. Tibia with two major spines on antero-dorsal margin, length of proximal spine more than half the length of distal one (Fig. 3d); antero-ventral margin with one major spine; outer surface finely granulate, with several setiferous tubercles. Tarsus completely divided (claw clearly demarcated by articulation), with two denticles on antero-dorsal margin: proximal denticle slightly longer than half the length of distal one, distance between them about three times basal diameter of proximal denticle; cleaning organ ventrally with 28-30 modified hairs; several blunt setae on inner surface of tarsus; apotele present.

Legs (Fig. 3e): Femora of Legs IIV with small setiferous tubercles. Tibia and tarsus of leg I with 23 and 41 segments, respectively; tibiae of leg II and III two-segmented; basitibia of leg IV four-segmented: fourth segment with one trichobothrium (value in parentheses as for *S. willeyi*), *bt* (0.57); distitibiae of Legs II-IV with 18 trichobothria, *bf* (0.13), *sbf* (0.32), *bc* (0.23), *bt* close to distal margin, *bc* at the middle of *bf* and *sbf*, (Fig. 3e). Tarsi of Legs II-IV four-segmented; first segment slightly

longer than length of subsequent three segments combined; second segment with light yellow transverse line; fourth segment without oblique slit; pulvilli present.

Genitalia (Figs. 3f, g): Covered ventrally by genital operculum, of which posterior margin is equipped with paired setae; posteriorly with paired ventral and dorsal lobes, the dorsal lobe smaller than ventral one (Fig. 3f). In dorsal view, submedian brown bands running from anterior margin to the middle; inner margin of median lobe with brown region weakly sclerotized; brown spot present on each median lobe. In ventral view, base of ventral lobe with a narrow brown band (Fig. 3g).

Female: Similar to the male but differing as follows: carapace slightly darker; chelicera with three frontal fine setae; meta-sternum slightly more elongate, with two apical setae; tibia and tarsus of leg I respectively with 26 and 42 segments. Gonopods soft, cone-shaped, with several setae on margin of genital operculum (Fig. 3h).

Measurements.—Male (holotype, MNHN.Am.6) [female (paratype, MZB.AmbI.134)]; values for segments of the appendages are their lengths: Body length (excluding chelicera) 9.50 [8.25]. Carapace: median length 3.75 [3.50], width 5.00 [5.00]; median eye to anterior margin 0.05 [0.05], distance between lateral eyes 2.60 [2.25], lateral eye to anterior margin 0.60 [0.65], lateral eye lateral margin 0.20 [0.25]. Pedipalps: trochanter 1.00 [1.15], femur 3.20 [2.50], patella 3.25 [3.00], tibia 1.50 [1.25], tarsus 1.60 [1.50]. Leg I: femur 10.00 [10.15], patella 0.75 [0.75]. Leg II: femur 6.00 [5.75], patella 1.00 [1.00], basitibia 5.00 [4.90], distitibia 3.00 [2.90], metatarsus+tarsus 2.55 [2.60]. Leg III: femur 7.25 [6.50], patella 1.10 [1.25], basitibia 6.35 [6.25], distitibia 3.50 [3.25], metatarsus+tarsus 2.95 [3.00]. Leg IV: femur 6.50 [5.75], patella 1.00 [1.00], basitibia 7.25 [6.75], distitibia 2.95 [2.75], metatarsus+tarsus 3.00 [3.00].

Remarks.—*Sarax newbritainensis* is distinguished from the other *Sarax* species known from New Britain, *S. willeyi*, by the generally larger body, the distinctly paler coloration, the carapace proportionally less wide (about 1.3 times as wide as long, while about 1.5 times in *S. willeyi*) and without distinct lateral sulci, the eyes reduced in size, the strongly elongated legs, and the number and arrangement of the trichobothria as given in the key.

Natural history.—We collected the specimens of *S. newbritainensis* from the caves called Resurgence of Lali Bairaman in New Britain. The species has characteristics typical of cave dwellers such as small eyes, elongate legs, and pale body color.

Distribution.—This species is known only from the type locality in New Britain (Papua New Guinea) (Fig. 5).

Sarax monodenticulatus new species
(Figs. 1c, 4a-h)

Type material.—Holotype male, Indonesia, West Papua Province, Waigeo Island, Mumes (00°21.23'S, 130°58.93'E), under stone in limestone forest, Raja Ampat Regency, 10 June 2007, C. Rahmadi, E-Win 2007 LIPI (MZB.AmbI.135). Paratypes: 1 female (MZB.AmbI.136), 1 male (MNHN.Am.7), 2 juveniles (MZB.AmbI.140), same data as holotype; 4 males (MZB.AmbI.137, 138, 141, 143), 3 females (MZB.AmbI.139, 142, 144), Air Dingin Monfaya (Resurgence), Wairabiae Lopintol (00°18.13'S, 130°56.09'E), under stone in limestone forest, Raja Ampat Regency, 4 June 2007, C. Rahmadi.

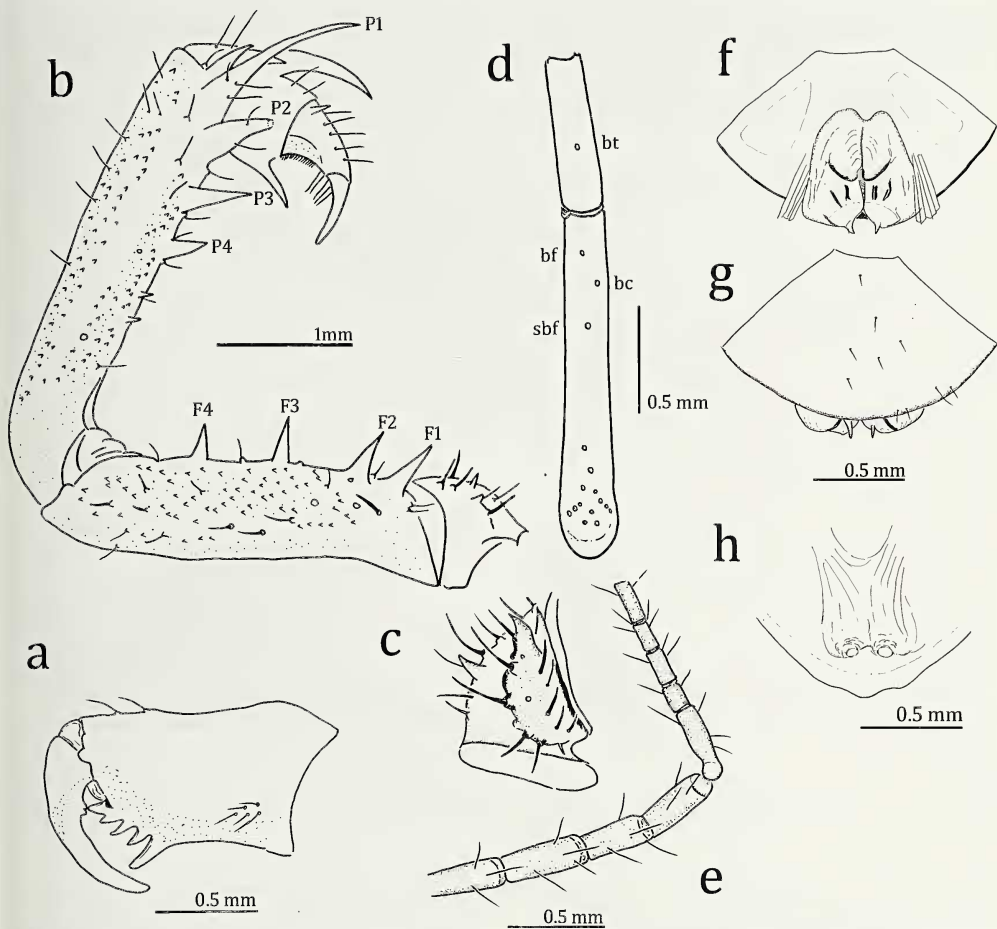


Figure 4.—*Sarax monodenticulatus*, new species, from Waigeo Island, Indonesia. a. External view of left chelicerae; b. Antero-dorsal view of left pedipalp; c. Antero-ventral view of left pedipalpal trochanter; d. Arrangement of trichobothria on fourth basitibial segment and distibia of left leg IV; e. Apical four tibial and basal five tarsal segments of antenniform leg I; f, g. Male genitalia (f. dorsal view; g. ventral view); h. Dorsal view of female gonopods.

Etymology.—The specific name refers to the presence of one denticle on the pedipalpal tarsus.

Diagnosis.—*Sarax monodenticulatus* differs from other congeneric species in the region by being small- to medium-sized (adult body length 2.5–6.5 mm) and with a reddish-brown carapace. The pedipalpal tarsus has a single denticle. Metatarsus of leg I as long as the subsequent two segments together; short- and long-segment alternating combination present in second to eleventh tarsal segments.

Description.—*Male*: Color in alcohol: Carapace dark reddish-brown with darker marks; pedipalp dark brown but

pedipalpal tarsus light brown. Legs I–IV brown, without annulations, but tibia and tarsus of leg I yellowish brown, with white annulations. Basitibiae of Legs II–IV brown; their distibiae and tarsi greenish-brown. Abdomen dark brown; each tergite with yellow marginal line and light-brown spots.

Carapace (Fig. 1c): Width about 1.5 times its length; surface finely granulate; frontal area with dense, small tubercles, without setiferous tubercles; median sulcus present in posterior one-fourth of the carapace. Flange present in area posterior to lateral eyes, wide but narrow in posterior margin, bent upward. Anterior margin of carapace rounded, with six

frontal setae and some fine setae close to antero-lateral corner. Median eye tubercle black, without apical setae, slightly emarginated antero-medially to form heart shape; eyes facing antero-laterally. Lateral eye large, with normal pigmentation and tapetum, separated from lateral margin of carapace by about its diameter. Frontal process triangular, visible from above.

Chelicera (Fig. 4a): Dorsum smooth, with two fine frontal setae and several setae on dorsal and lateral parts of outer margin. Basal segment with four teeth: lowermost tooth largest, uppermost tooth bicuspid, with upper cusp larger than lower one; inner surface with eight setae arranged in a vertical row close to proximal margin; outer surface with a small blunt tooth and five setae near proximal margin. Movable hand with two teeth close to the proximal margin.

Sternum: First sternite (= tritosternum) elongate, with paired apical and median setae, paired small setae between apical and median setae, and four small setae basally. Second and third sternites rounded, each with paired apical setae.

Pedipalp (Figs. 4b, c): Strong and slender, with several setiferous tubercles and small tubercles. Antero-dorsal margin of trochanter with four setiferous tubercles dorsally, two spines and seven setiferous tubercles ventrally; antero-ventral margin with ventral anterior apophysis basally equipped with several setiferous tubercles; ventral anterior apophysis with one spine medially and one spine dorsally (Fig. 4c). Femur with four major spines, several setiferous tubercles and small scales on the antero-dorsal margin, length of spine $F1 > F2 > F3 > F4$; five major spines, two minor spines, four setiferous tubercles and small scales present on antero-ventral margin, one spine present dorsally of $F1$ and about as long as $3/4$ length of $F1$, length of spine $F1 > FII > FIII > FIV$, single minor spine present between FII and $FIII$ and between $FIII$ and FIV . Patella with four major spines, several setiferous tubercles and small scales on antero-dorsal margin, length of spine $P1 > P2 > P3 > P4$, one minor spine present between distal margin and $P1$ and as long as half of the length of $P1$, two spines and one setiferous tubercle present between $P4$ and the proximal margin; three major spines and one minor spine, several setiferous tubercles and small scales on antero-ventral margin, length of spine $PI > PII > PIII$, one minor spine between $PIII$ and the proximal margin. Tibia with two major spines on antero-dorsal margin: proximal spine slightly longer than half of distal one; one major spine on antero-ventral margin close to distal margin; outer surface finely granular, with setiferous tubercles arranged in three rows. Tarsus completely divided (claw clearly demarcated by articulation), with one denticle on antero-dorsal margin; blunt setae present on inner surface; cleaning organ ventrally with 27–28 modified hairs; apotele present.

Legs (Figs. 4d, e): Femora of Legs I–IV with small scales and setae forming a longitudinal row. Tibia and tarsus of leg I with 23 and 41 segments, respectively (Fig. 4e); tibiae of legs II–III two-segmented; basitibia of leg IV four-segmented (in some specimens left basitibia three-segmented): fourth (third in specimen with three basitibial segments) segment with one trichobothrium (value in parentheses as for *S. willeyi*) *bt* (0.61); distitibiae of legs II–IV each with 16 trichobothria (Fig. 4d), *bf* (0.10), *sbf* (0.30), *bc* (0.17), *bc* about the middle of *bf* and *sbf*, *bt* close to distal margin. Tarsi of legs II–IV four-

segmented; first segment about as long as length of the subsequent three segments combined; second segment with light yellow transverse line; fourth segment without oblique slit; pulvilli present.

Genitalia (Figs. 4f, g): Covered ventrally by genital operculum equipped with several setae; distally with paired small submedian lobes. In dorsal view, with paired large median lobes, of which distal margins are brown; four longitudinal sclerotized bands present posterior to median lobes (Fig. 4f). In ventral view, brown band present near base of distal lobe (Fig. 4g)

Female: Similar to the male. Gonopods soft and cone-shaped (Fig. 4h)

Measurements.—Male ($n = 5$) [female ($n = 4$)]; values for segments of the appendages are their lengths: Body length (excluding chelicera) 4.88–6.48 [2.48–5.60]. Carapace: median length 1.88–2.60 [2.00–2.48], width 2.60–3.72 [3.00–3.60]; median eyes to anterior margin 0.04–0.08 [0.04–0.08], distance between lateral eyes 1.20–1.80 [1.40–1.72], lateral eye to anterior margin 0.28–0.44 [0.36–0.40], lateral eye to lateral margin 0.12–0.16 [0.08–0.16]. Pedipalps: trochanter 0.40–1.00 [0.60–0.80], femur 1.20–3.08 [1.40–2.20], patella 1.40–3.52 [1.60–2.64], tibia 0.60–1.20 [0.68–1.00], tarsus 0.08–1.12 [0.60–1.20]. Leg I: femur 3.08–5.40 [3.40–4.80], patella 0.52–0.60 [0.40–0.48]. Leg II: femur 2.00–3.40 [2.40–3.20], patella 0.48–0.64 [0.48–0.72], basitibia 1.36–2.40 [1.60–2.40], distitibia 1.12–1.60 [1.20–1.60], metatarsus+tarsus 1.00–1.60 [1.20–1.36]. Leg III: femur 2.40–4.00 [2.80–3.60], patella 0.48–0.72 [0.56–0.60], basitibia 1.88–3.32 [1.88–3.00], distitibia 1.20–1.80 [1.36–1.68], metatarsus+tarsus 1.20–1.60 [1.20–1.44]. Leg IV: femur 1.20–3.48 [2.40–3.28], patella 0.60–2.80 [0.44–0.60], basitibia 0.48–3.20 [2.16–3.04], distitibia 1.40–2.80 [1.40–1.60], metatarsus+tarsus 1.04–1.80 [1.20–1.52].

Remarks.—This species is the only Papuan *Sarax* with a single denticle on the pedipalpal tarsus. The other *Sarax* species that have the single denticle on the pedipalpal tarsus are *S. javensis* (Gravely 1915) distributed in West Java and *S. cochinesis* (Gravely 1915) known from the Western Ghats in Cochin, India. Gravely (1915) distinguished the two species by the length of the denticle; the denticle of *S. cochinesis* is long and distinct, while in *S. javensis* it is minute (see Gravely 1915: figs. 2, 3). *Sarax monodenticulatus* is distinguished from these two species by having four-segmented basitibia (single- or two-segmented in *S. cochinesis* and three-segmented in *S. javensis* [see Gravely 1915: 437]).

Natural history.—We collected specimens of this species mostly singly under stones in limestone forests. During the exploration of cave fauna in Waigeo Island, it was never found within the caves.

Distribution.—*Sarax monodenticulatus* is known only from Waigeo Island (Indonesia) (Fig. 5).

DISCUSSION

The first record of whip spiders of the genus *Sarax* from New Guinea was by Kraepelin (1895), who reported specimens without giving any precise data under the name *S. sarawakensis*, which was originally described from Borneo by Thorell (1888). Kraepelin (1895) also treated *S. brachyductylus* Simon 1892 described from Luzon Island, the Philippines, as a synonym of *S. sarawakensis*. Pocock (1898) recorded *S.*

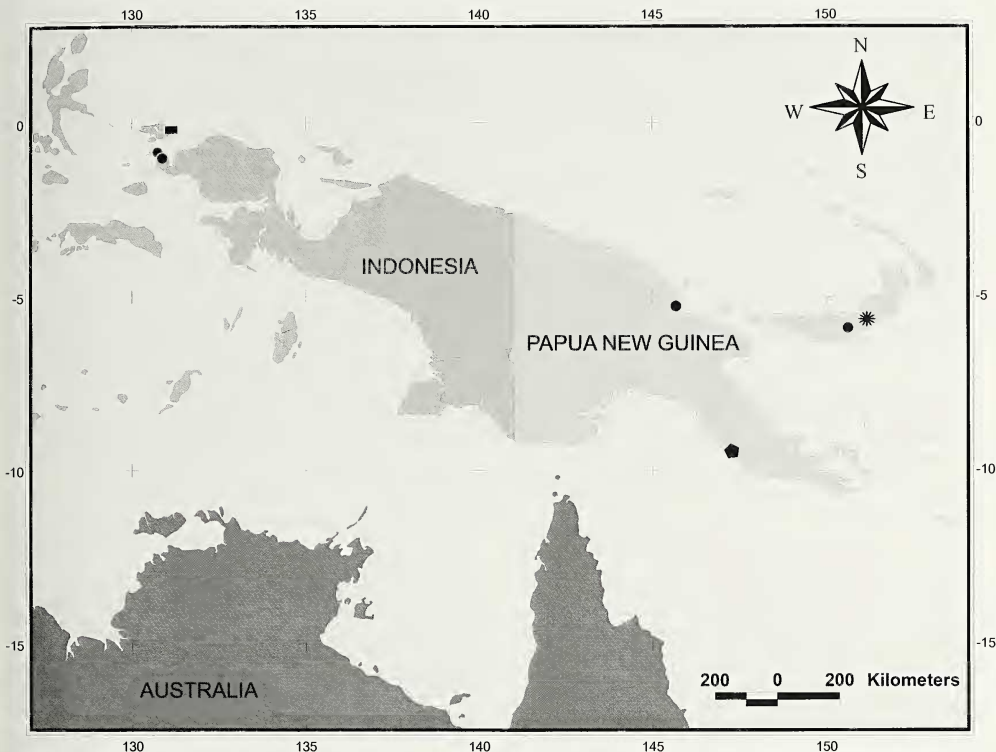


Figure 5.—Map showing the distribution of charinid species in the Papuan region. Symbols used: circle, *Sarax willeyi* from Batanta Island, Salawati Island (Indonesia), Madang and New Britain (Papua New Guinea); flower, *Sarax newbritainensis*, new species from New Britain; rectangle, *Sarax monodenticulatus*, new species from Waigeo Island (Indonesia); polygon, *Charinus papuanus* from Port Moresby (Papua New Guinea).

sarawakensis from New Britain and, following the view of Kraepelin (1895), remarked on its occurrence in Borneo, the Philippines, and New Guinea. Gravely (1915), on the other hand, described a species from New Britain as distinct from *S. sarawakensis* under the name *Salax willeyi*, possibly based on the specimens that Pocock (1898) identified as *S. sarawakensis* (see remarks in the section of *S. willeyi*). Consequently, the occurrence of *S. sarawakensis* in the Papuan region needs reconfirmation. Among the specimens from the Papuan region we have so far examined, we have not recognized any specimens of *S. sarawakensis*.

Sarax newbritainensis is very similar to *S. willeyi*, but can be distinguished from *S. willeyi* by the number and arrangement of the trichobothria. Compared with *S. willeyi* and *S. monodenticulatus*, both of which live outside caves, *S. newbritainensis* is larger in adult body size, has a pale body color, smaller median and lateral eyes, and strongly elongate legs, all characteristics highly adapted to cave environments. Such troglomorphic features have not so far been reported

amongst *Sarax*, while several species of a similar genus, *Charinus*, are known to have such features (Baptista & Giupponi 2002; Weygoldt et al. 2002; Weygoldt & Van Damme 2004).

ACKNOWLEDGMENTS

Mark Judson (MNHN, Paris, France) and Giuliano Doria (MCSG, Genova, Italy) arranged the first author's access to the specimens in their respective institutes. Franck Brehier (Toulouse, France) provided the first author with an opportunity to examine the specimens from New Britain. Collections of *S. willeyi* by R. M. Clouse, Ulai and Nataniel in Papua New Guinea were funded by Putnam Expedition Grants (MCZ) for R. M. Clouse (Harvard University) who arranged a loan of the specimens. Daisy Wowor and Hari Nugroho (Museum Zoologicum Bogoriense, Bogor, Indonesia) organized the zoological team in the E-WIN Expedition to Waigeo Island and Batanta Island. Matjaz Kuntner critically

read an earlier draft of the manuscript and provided us with comments and suggestions to improve the manuscript.

LITERATURE CITED

- Armas, L.F. de & Y. Gadar. 2004. Nueva especie de *Phrynus* Lamarck, 1801 (Amblypygi: Phrynidae) de Chiapas, México. *Revista Ibérica de Aracnología* 10:133–136.
- Baptista, R.L.C. & A.P. de Leão Giupponi. 2002. A new troglomorphic *Charinus* from Brazil (Arachnida: Amblypygi: Charinidae). *Revista Ibérica de Aracnología* 6:105–110.
- Gravely, F.H. 1915. A revision of the Oriental subfamilies of Tarantulidae order Pedipalpi. *Records of the Indian Museum* 11:433–455.
- Harvey, M.S. 2002. The neglected cousins: what do we know about the smaller arachnid orders. *Journal of Arachnology* 30:357–372.
- Harvey, M.S. 2003. Catalogue of the Smaller Arachnid Orders of the World: Amblypygi, Uropygi, Schizomida, Palpigradi, Ricinulei and Solifugae. CSIRO Publishing, Collingwood, Victoria, Australia.
- Harvey, M.S. & P.L.J. West. 1998. New species of *Charon* (Amblypygi, Charontidae) from northern Australia and Christmas Island. *Journal of Arachnology* 26:273–284.
- Kraepelin, K. 1895. Revision der Tarantuliden Fabr. *Verhandlungen des Naturwissenschaftlichen Vereins in Hamburg* 13(3):3–53.
- Kraepelin, K. 1899. Scorpiones und Pedipalpi. Pp. i–xviii, 1–265. *In* Das Tierreich. 8. Arachnoidea. (F. Dahl, ed.). R. Friedlander und Sohn Verlag, Berlin.
- Kraus, O. 1970. Genitalmorphologie und systematique der Amblypygi (Arachnida). *Bulletin du Muséum National d'Histoire Naturelle, Paris* (Supplement 1):176–180.
- Mello-Leitão, C. 1931. Pedipalpos do Brasil e algumas notas sobre a ordem. *Archivos do Museu Nacional* 33:7–72.
- Pocock, R.I. 1898. Scorpions, Pedipalpi and spiders collected by Dr. Willey in New Britain, the Solomon Islands, Loyalty Islands, etc. Pp. 95–120. *In* Zoological Results Based on Material from New Britain, New Guinea, Loyalty Islands and Elsewhere, Collected During the years 1895, 1896 and 1897, Part 1 (A. Willey, ed.). Cambridge University Press, Cambridge, UK.
- Pocock, R.I. 1900. The Fauna of British India, Including Ceylon and Burma. Arachnida. (W.T. Blanford, ed.). Taylor and Francis, London.
- Rahmadi, C. & M.S. Harvey. 2008. The first epigeal species of *Stygophrynus* (Charontidae, Amblypygi) from Java and adjacent Islands with notes on *S. dammermani* Roever, 1928. *Raffles Bulletin of Zoology* 56:281–288.
- Simon, E. 1892. Arachnides. *In* Etude sur les Arthropodes cavernicoles de île Luzon, Voyage de M. E. Simon aux îles Philippines. Mars et avril 1890. (A. Raffray, I. Bolívar & E. Simon, eds.). *Annales de la Société Entomologique de France* 61:35–52.
- Thorell, T. 1888. Pedipalpi e Scorpioni dell'Arcipelago Malese conservati nel Museo Civico di Storia Naturale di Genova. *Annali del Museo Civico di Storia Naturale di Genova* 26:327–428.
- Werner, F. 1935. Klasse: Arachnoidea, Spinnentiere. Pedipalpen. Pp. 317–490. *In* Klassen und Ordnungen des Tierreichs, Volume 5(IV),(8)(3). (H.G. Bronn, ed.). Akademische Verlagsgesellschaft, Leipzig.
- Weygoldt, P. 2000. Whip Spiders: Their Biology, Morphology and Systematics. Apollo Books, Stenstrup, Denmark.
- Weygoldt, P. 2002. Sperm transfer and spermatophore morphology of the whip spiders *Sarax buxtoni*, *S. brachydactylus* (Charinidae), *Charon* cf. *grayi*, and *Stygophrynus brevispinia* nov. spec. (Charontidae). *Zoologischer Anzeiger* 241:131–148.
- Weygoldt, P. 2005. Biogeography, systematic position, and reproduction of *Charinus ioanniticus* (Kritscher 1995) with the description of a new species from Pakistan (Chelicerata, Amblypygi, Charinidae). *Senckenbergiana Biologica* 85:43–56.
- Weygoldt, P. 2006. New Caledonian whip spiders: Notes on *Charinus australianus*, *Charinus neocaledonicus* and other south-western Pacific species of the *Charinus* species group (Chelicerata, Amblypygi, Charinidae). *Verhandlungen des naturwissenschaftlichen Vereins Hamburg* 42:5–37.
- Weygoldt, P., H. Pohl & S. Polak. 2002. Arabian whip spiders: four new species of the genera *Charinus* and *Phryniichus* (Chelicerata: Amblypygi) from Oman and Socotra. *Fauna of Arabia* 19:289–309.
- Weygoldt, P. & K. Van Damme. 2004. A new troglomorphic whip spider of the genus *Charinus* (Amblypygi: Charinidae) from Socotra Island. *Fauna of Arabia* 20:327–334.

Manuscript received 29 October 2009, revised 15 December 2009.